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ABSTRACT

This paper focuses on the professional development of early childhood teachers in mathematics and science, examining the challenges posed by the increasing need for early childhood teachers, especially for children from culturally and linguistically different backgrounds. The paper discusses the current status of professional development for early childhood teachers and points out the variation in quantity and quality of field experiences for early childhood teachers and the limited focus on mathematics and science in professional development. The paper next presents standards for professional development of the early childhood teacher with reference to mathematics and science, synthesized from the National Science Education Standards, Professional Standards for Teaching Mathematics, and the Professional Standards for Early Education, to: (1) develop good dispositions toward mathematics and science; (2) experience good teaching in mathematics and science; (3) focus on learning about children and the mathematics and science content of specific interest to them; (4) participate in a variety of professional development opportunities situated in a learning community; (5) demonstrate an ability to implement integrative curriculum; and (6) utilize appropriate strategies to establish family partnerships. The paper then describes four professional development programs in Texas focusing on early childhood mathematics and science instruction, specifically trainer of trainer modules, study groups with math and science emphases, a graduate class for early childhood teachers on young children's reasoning and thinking and appropriate math and science, and the Collaborative Coaching Project. (Contains 12 references.) (KB)

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PREPARING TEACHERS OF YOUNG LEARNERS: PROFESSIONAL DEVELOPMENT OF EARLY CHILDHOOD TEACHERS IN MATHEMATICS AND SCIENCE

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Juanita Copley
Yolanda Padrón

"I wish just once our principal would do some kind of workshop or in-service program just for us...I am tired of being included in all the state testing workshops for grades 1-6!"

... A pre-kindergarten public school teacher

"I just want to teach three-year-olds at my preschool. I know I want to concentrate on their language and social skills. I really don't have to do any math or science, do I? I was never good at math and I always avoided science. In fact, that's one of the reasons I chose early childhood... I don't have to know math or science!"

... A preschool teacher working on her associate's degree

"What is appropriate for young children? Is the water table the only science children should learn? Are counting activities with the calendar the only important things in kindergarten mathematics? I can't tell what is really going on every time I observe the kindergarten class. Early childhood classrooms are places I don't understand and I don't know how to help my beginning teachers or evaluate my experienced ones."

... An elementary principal in a public school

"We only learn about philosophy and theories. I am frightened to death of student teaching. I don't know if I can do it"

... A senior at a university one semester before student-teaching

"I think I want to be a teacher... it sounds like a good job. More people should be working with young children and teaching them mathematics and science concepts. I want to get alternative certification and begin immediately … I figure I know all the mathematics and science I need... and teaching can't be that hard!"

.... A chemist who had just enrolled in an early childhood curriculum class in a college of education

The professional development of early childhood teachers is of critical importance to the young children in our country. Enrollment in preprimary education for ages 3 to 5 has increased 37 percent between 1984 and 1995, with the greatest increase in the four-year-old population. In addition, projections based on the most recent census indicate that there will be a 12 percent increase in total elementary school enrollment over the next ten years. The testimonials above, combined with the growing number of pre-primary programs, indicate a need for more pre-service training. It is also clear that both pre-service and in-service teachers will require specialized training to help them understand and instruct the increasing number of children with a variety of needs, children from various socioeconomic backgrounds, exceptional children, and children who are enrolled in state-required, pre-kindergarten programs.

Perhaps one of the greatest challenges, however, will be to address the educational needs of children that come from culturally and linguistically different backgrounds. Projections for the year 2020 indicate that people of color will comprise 46 percent of the student population. Not only will teachers continue to have many students from diverse cultural backgrounds, but many of the students will also have diverse language backgrounds. The number of school-age children from various language backgrounds has continued to increase at a rate of 12.6 percent; while the overall student population increased at a rate of only one percent. Most teachers have not received training in English as a second language or bilingual education, yet children who are learning English will be mainstreamed into "regular" classrooms. Consequently, early childhood teachers will be expected to teach reading, writing, mathematics, and science as well as

help children develop their oral English skills. To effectively teach these young children, both pre-service and in-service teachers require professional development opportunities in many areas. For the purposes of this paper, specific professional development opportunities for the early childhood teacher in the often-neglected areas of mathematics and science will be addressed.

According to the 1997 National Education Goals Report (National Education Goals Panel, 1997), most mathematics teachers, while knowledgeable about reforms, do not exhibit many of the behaviors suggested by those reforms in the classroom. In addition, while 85 percent of in-service teachers participate in professional development programs, these same teachers receive little support at the beginning of their teaching careers through apprenticeship programs and other kinds of opportunities to interact with more experienced teachers. The Goals Panel report recommends that teachers' subject-matter knowledge and teaching skills in mathematics and science be strengthened. While little research addresses the competencies of early childhood teachers in mathematics and science, data collected from a four-year study revealed that early childhood teachers generally like to teach reading and other language-oriented skills. Mathematics and/or science were difficult subjects—ones they felt unable to teach.

Knowledge of and interest in mathematics and science, however, are not the only determinants of good instruction. Teachers serving economically disadvantaged, limited-English proficient, or lower-achieving students often devote less time and emphasis to the higher-level thinking skills so important to the learning of mathematics and science than do teachers serving more advantaged students. Since the expectations set for children to learn mathematics and science play an important role in determining students'

achievement, the professional development of early childhood teachers must address the content, process, and dispositions associated with all learners in mathematics and science.

THE CURRENT STATUS OF PROFESSIONAL DEVELOPMENT FOR EARLY CHILDHOOD TEACHERS

Currently, there is a large distinction between childcare workers in day care situations and certified teachers in public or private schools. Childcare workers have a wide range of credentials—some have attended one or two workshops and others are practitioners with an associate or child development associate (CDA) credential. Certified teachers in public or private schools often have provisional early childhood certification and a bachelors, masters, or doctoral degree.

Normally, field experiences (short-term workshops, observations, simulations, practica, student teaching, and apprenticeship programs) are components of early childhood professional development programs; however, there is a wide range in both the quantity and quality of such programs. According to the 1997 National Educational Goals Report (National Goals Panel, 1997), teachers in public elementary schools were more likely to participate in workshops or in-service programs (93 percent) than they were to take college courses (38 percent) or participate in activities sponsored by professional associations (50 percent).

Few professional development programs focus specifically on mathematics and science concepts in early childhood. Instead, the primary foci of professional

development for early childhood teachers include definitions of developmentally appropriate curriculum, emergent literacy, management strategies, and the importance of play and strategies to improve social and emotional development.

The National Commission on Teaching and America's Future (1996) proposed five recommendations to improve and professionalize teaching. Two of those recommendations discuss the importance of professional development standards, specifically stating that teacher preparation and professional development programs should be reinvented and organized around standards. In addition, the Commission recommended the funding of new mentoring programs that adhere to these standards. Several other documents propose specific teaching standards for science and mathematics or for early childhood educators, but no document exists that integrates these standards.

INTEGRATED PROFESSIONAL STANDARDS FOR EARLY CHILDHOOD MATHEMATICS AND SCIENCE TEACHERS

To create standards for professional development of the early childhood teacher with specific reference to mathematics and science, we synthesized three different sets of professional standards:

- *National Science Education Standards* (National Research Council, 1996);
- *Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics, 1991); and

- *The Professional Standards for Early Childhood* (National Association for the Education of Young Children, Council for Exceptional Children, and National Board for Professional Teaching Standards, 1996).

The integration of these standards highlighted both elements common to all of the documents and elements specific to early childhood or mathematics and science. Together, the documents indicate that both pre-service and in-service programs should provide experiences and opportunities for teachers to:

A. Develop Good Dispositions toward Mathematics and Science

Because of the frequently expressed phobic reactions of early childhood teachers to mathematics and science, this is an essential component of any professional development program for teachers of young children. Confidence inspired by learning mathematics and science concepts along with successful pedagogical experiences are critical to the development of early childhood professionals who model positive dispositions toward mathematics and science for their young students.

B. Experience Good Teaching in Mathematics and Science

No lecture, assigned readings, or observations can take the place of learning mathematics and science from an excellent teacher. The enthusiasm generated in the process of inquiry, the communication involved when solving problems with a small group, and the knowledge shared as different reasoning strategies are discussed are just a few of the processes that must be experienced as learners.

C. Focus on Learning about Children and the Mathematics and Science Content of Specific Interest to Them

All early childhood teachers must be focused on children, how they learn, and their interests in the world around them. Listening to children's questions, assessing their understanding and unique abilities, understanding their natural inquisitiveness, managing and monitoring their learning, and designing their instruction to address children's learning are all skills that must be part of an effective professional development program.

D. Participate in a Variety of Professional Development Opportunities Situated in a Learning Community

All three sets of professional standards emphasize the importance of apprenticeship and mentoring experiences shared with both experienced and inexperienced teachers. In addition, teacher-designed professional development experiences and opportunities that are varied and specific to identified needs are critical. The growing diversity of the children in our schools requires that early childhood teachers have opportunities to learn about children with special needs, children who are culturally and linguistically different, children who come from various socioeconomic backgrounds and children who are enrolled in state-required, pre-kindergarten programs.

E. Demonstrate an Ability to Implement Integrative Curriculum

An integrated approach to early childhood curriculum has been advocated and practiced for years in the early childhood community. Often this has resulted in an over-

emphasis on disciplines that teachers feel most comfortable with and a neglect of mathematics and science. The importance of intellectual integrity and sufficient time engaged in mathematics and science must be emphasized in a professional development program, along with practice in effectively integrating appropriate curriculum.

F. Utilize Appropriate Strategies to Establish Family Partnerships

The importance of the family to the learning of the young child is emphasized in the National Education Goals that were established by Congress and the governors in 1990. A parent's statements that "I was never good in math" or "I never had a scientific mind" are often communicated to young children and can stifle a child's desire to learn those subjects. Partnerships between school and family are essential to overcoming these and other obstacles in early childhood programs. If the partnerships include mathematical and science concepts, they can also lead to effective professional development for early childhood mathematics and science teachers.

WHAT WORKS?

Professional development programs that specifically focus on the early childhood teacher and mathematics and science instruction are difficult to identify. This section describes four of our programs that have focused on the professional development of early childhood teachers and their understanding of mathematics and science. All of these programs have taken place in the Houston metropolitan area, education regions in Texas,

or within the surrounding school districts or daycare centers. The programs we describe here are in no way the only programs that work; however, there are several commonalties between these and other effective programs and with the integrated standards. Our discussion focuses on a sequential description of each program as it was developed, the relationship between the program components and the integrated standards introduced in the previous section, and some general comments from participants in each program.

Trainer of Trainer Modules

Eisenhower grants and the Texas Education Agency funded the development of thirty-seven professional development modules. As part of the grant, each of the regional centers in the state received manipulatives and software kits along with the provisions to train trainers. Six modules, each consisting of a two-day interactive training session for in-service teachers, were written specifically for early childhood teachers in mathematics. The sessions combined learner-focused activities and pedagogy suggestions in a traditional professional development program. Activities were written and field-tested by classroom teachers and evaluated by early childhood experts and mathematics teachers. Highly dependent on the effectiveness of the trainer, this program addressed the first three integrated standards effectively and provided a short-term professional development opportunity for in-service teachers.

Study Groups with Mathematics and Science Emphases

Study groups have been used successfully in public schools, private schools, and day care centers. Rather than a formal presentation by an expert, study groups are

normally led by a teacher and based on reflections of assigned readings and classroom observations. In one local school district, representative early childhood teachers (pre-K to grade 2) meet monthly with other teachers in the district (grades 3 through 12) to discuss mathematical concepts and the *Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics, 1991). Representatives of this math council are responsible for sharing the information with other teachers at their school. Both teachers and administrators regard the study group as "a key professional development experience."

Another study group takes place in a highly respected daycare center in Houston. The teachers of three-, four-, and five-year-old children meet weekly to discuss readings specific to early childhood, child development, assessment, and mathematics and science. The lead teachers often consult early childhood experts to plan the group's activities or readings. Frequent evaluations of the program provide information for any needed adaptations.

The study group approach has also been used in graduate classes. In one instance, eight doctoral students met weekly to discuss their videotaped interactions with young children. Students asked each other why they questioned children as they did, why they used certain materials, or why they responded to children as they did. They then analyzed and discussed their responses.

Each of these study groups has its own unique characteristics. All of them incorporated the first four integrated standards; however, the teachers interacted only with other group members in their own learning community, reflecting and analyzing teaching

experiences. Many of the discussions focused on integrated curriculum, more positive dispositions toward mathematics and science, and the assessment of young children.

The success of this approach is highly individual and specific to the group. One of the participants expressed it in this way: "I have an undergraduate and a graduate degree in early childhood and I have been to countless workshops on mathematics and science. This study group has changed my teaching more than any other type of professional development. The taping, critiques, discussions, readings, and sharing of our personal experiences has given me a new perspective on children and my interactions with them. I am a different teacher."

"Problem Solving for the Young Child": A Graduate Class

To teach integrated curriculum appropriate for young children, we specifically designed a graduate class for early childhood teachers. The class deals primarily with assessing the young child's reasoning and thinking and the mathematics and science appropriate for young children. Since its introduction in 1994, the class has been taught four times to more than one hundred students. Currently, the Houston Independent School District uses its Eisenhower funds to pay the full tuition of early childhood teachers from the district who are enrolled in the class. Class assignments include:

- classroom coaching experiences,
- presentation of a district-wide series of workshops on mathematics and science,
- mentorship of a pre-service early childhood teacher, and
- portfolios containing assessments of children's learning in mathematics and science.

This class has become a unique way to blend both pre-service and in-service professional development programs. During the class sessions, the in-service teachers experience good mathematics and science teaching, model the pedagogy necessary to transfer knowledge into practice, write and implement integrated curriculum, and then share their knowledge with pre-service teachers through workshops and mentoring programs. Adding the important early childhood standard of curriculum integration, this program (i.e., the class) successfully implemented the first five integrated professional standards.

Student evaluations of this graduate class have been extremely favorable; in fact, four other school districts in the area have asked for similar programs. Teachers' enthusiasm for this type of professional development were reflected in comments such as:

- "The teachers presented the best workshop we've had in years!"
- "My mentor was fantastic...she really knew what she was talking about."
- "I learned so much from my assessment portfolio...four-year-olds are so smart... they solve problems in so many ways and come up with such interesting answers."
- "Math and science fit so well together...I can teach so much when I look at curriculum this way."

Collaborative Coaching Project

To support the professional development of practicing early childhood teachers as well as new early childhood teachers, the University of Houston has sponsored a collaborative coaching community project for the past three years. An early childhood professor adopted a public elementary school close to the university. Every Tuesday, eighteen pre-service teachers (teacher candidates who have not yet begun the field-based

methods courses or student teaching) spend all day at the school in three collaborative coaching sessions, one teaching modeling session, and one debriefing session.

Working in teams of three, the pre-service teachers teach a previously planned mathematics or science lesson to kindergarten or pre-kindergarten students enrolled at the school. As required, the pre-service teachers use peer-coaching techniques with each other as they observe children and their peers' teaching. When the pre-service teachers are teaching, the regular classroom teachers meet with the university professor to discuss mathematics and science lessons that they have taught during the week, experience some mathematics and science lessons as learners, discuss strategies for involving families in mathematics and science experiences, and reflect on the use of the professional teaching standards in their classroom. After each 70-minute session, the pre-service teachers debrief on their teaching experiences with the university professor. Two more of these sessions occur during the day with other early childhood classes. In the remaining time, the beginning teachers and practicing teachers observe the university professor as she teaches a mathematics or science lesson in selected classrooms or as she coaches the practicing teachers.

The Collaborative Coaching Project covers all six of the integrated professional standards, with the emphasis on the sixth standard: family partnerships. New and experienced teachers, children, and families are excited to teach and learn more mathematics and science. We received the following comments, which illustrate the positive disposition of all stakeholders:

- "I can't wait to teach math and science to young children... they've become my favorite subjects!"

- "I love it when the teachers from U of H come teach....we learned lots of neat stuff"
- "Math and science are everywhere at home...it's easy and fun to investigate with my child!"
- "I've learned more mathematics teaching these classes than I ever learned in four years of high school and four years of college!"

In addition, the assignments that required both beginning and experienced teachers to focus on children's learning and questions resulted in new knowledge for all members of the learning community. Increased scores on the state mathematics test and comments from teachers such as, "My children learned so much more when we did it this way," "I can't believe the ideas they have," and "Look at the way they solved this problem," underscore their belief in the program.

The Collaborative Coaching Project is indeed a program that benefits the pre-service teacher and the in-service teachers. Pre-service teachers get needed experience in teaching preplanned lessons to real children in real settings and then reflect on lessons taught with peer and professor input. In-service teachers experience professional development as part of their regular teaching day and then collaboratively reflect on lessons taught by themselves or the university professor. Most importantly, young children benefit from the project, which is the ultimate goal of any professional development. A child's comment as we left one day was simply expressed, "I hope you come back soon.... I'm so smart when you are here!"

CONCLUSIONS

> "....The terms and circumstances of human existence can be expected to change radically during the next life span. Science, mathematics, and technology will be at the center of that change—causing it, shaping it, responding to it. Therefore, they will be essential to the education of today's children for tomorrow's world" (American Association for the Advancement of Science, 1989)

In this paper, we have discussed the critical importance of professional development for early childhood teachers due to the growing and diverse student population in pre-primary education. In addition, we have indicated that although knowledge and preference for mathematics and science are essential in the professional development of pre-service and in-service teachers, other considerations must also be addressed when designing staff development programs for early childhood teachers. For example, teachers' attitudes towards the development of higher-level thinking skills for economically disadvantaged, limited-English proficient, or lower-achieving students must be addressed, since these skills are crucial to the learning of mathematics. The expectations set for children to learn mathematics and science also play an important role in determining students' achievement. The professional development of early childhood teachers, therefore, must address not only the content and processes involved in the teaching and learning of mathematics and science skills, it must also address dispositions associated with the teaching of concepts and skills in these content areas.

We have provided several examples of successful staff development programs specifically designed for early childhood teachers. We created these programs to adhere to integrated professional standards for the early childhood teacher specifically in

mathematics and science. The comments from teachers and students suggest that these programs were very successful. Furthermore, it is important to point out that the Collaborative Coaching Project has been very effective in terms of students' cognitive outcomes. Test scores for the state mathematics test have increased for those students whose teachers participated in the program. This increase on students' test scores is important since the goal of staff development is to help teachers improve their teaching and ultimately to improve students' academic achievement.

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National Center for Education Statistics: http://www.nces.ed.gov/

Federal Interagency Council on Statistical Policy: http://www.fedstats.gov/